

Maximus™ SFI – Measurement & Reduction of LP Gas Outage Gauge Emissions

(Averting Propane Emissions into the Atmosphere)

ARB Chair's Seminar Series

Presentation by Mr. Alex Spataru

March 19, 2009



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1273 Westwood Blvd., Suite 203, Los Angeles, CA 90024 -- Ph: (310) 478-3456 Fax: (310) 478-6335

Presentation Objectives

- Describe work conducted with the ICAT grant money.
- Describe LP Gas Emissions that occur along typical LP Gas distribution channels in California.
- Show how the Maximus™ Stop Fill Instrument (SFI) can eliminate a significant portion of these releases.



Why Should Refueling Processes LP Gas Releases Be Eliminated?

- (1) They contribute to Air Pollution:
 - (a) LP Gas is a blend of VOC's (precursors to low level ozone)
 - (b) GHG's (GWP = 3 to 20, depending on academic source)
- (2) They represent a proven fire hazard,
- (3) They waste a valuable energy commodity,
- (4) They can be a health hazard to LP Gas delivery personnel,
- (5) They frequently cause the loss of already paid-for product for the end-user who pays for but never gets to enjoy it (releases often occurs after the invoice generating meter).



Part I : Overview / Problem

- Problem:

LP Gas Emissions while refueling are a significant air pollution source. Everybody knows that LP Gas leaks whenever a tank or a cylinder is refilled. It is a fact, proof of which will be described in a moment and which is based on an uncontroversial evidence, that these are significant releases. What has in the past complicated this matter is that there's been misinformation: (1) on mass releases rates through outage gauges, and (2) on actual field refill practices.

The problem at hand was to quantify these releases and to come up with one possible cost-effective corrective action. It would be irresponsible to further ignore these releases and to fail to provide cost-effective prevention.



Part I: Overview/ Solution

- Solution:

Measure these releases and take appropriate corrective action. This entails three (3) steps: (1) scientifically measure the mass release rates through outage gauges, (2) quantify these collective releases for specific tank populations, and (3) develop and prove a technology based 21st century practical solution to eliminate the need to open outage gauges while tanks are refilled. Today, there are several technology based methods to remedy this situation. One such method is shown in this presentation.



Part I: Overview / Urgency

- Urgency:

The damage is occurring now and has been going on for decades. Given that the technology based solutions are both cost-effective and are available, there is every reason to upgrade ASAP refilling practices that have been unchanged since at least 1962.



Part II : How Extensive Is This Problem?

Question: **Is This a Widespread Problem?**

Answer: **YES**



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Reasons to Design and Build The Maximus™ Stop-Fill Instrument (SFI)



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Current LP Gas Refilling Practice (1)

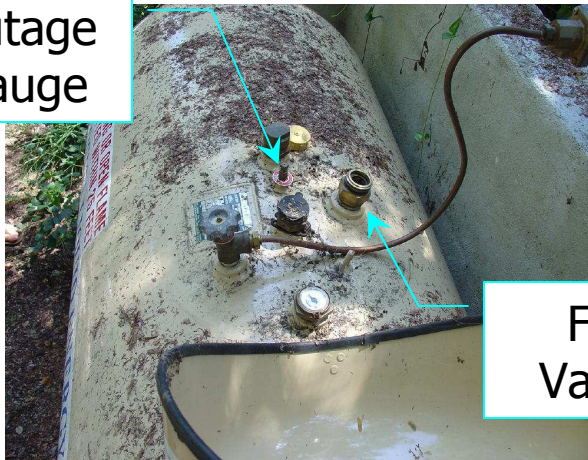


LP Gas
Bobtail



Residential
Tank

Outage
Gauge



Fill
Valve



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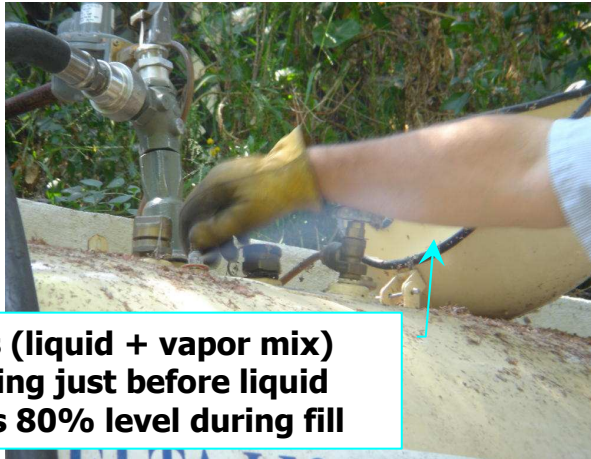
Current Refilling Practice (2)



Flow
Meter



LP Gas (liquid + vapor mix)
releasing through the outage
gauge at beginning of fill process



LP Gas (liquid + vapor mix)
releasing just before liquid
reaches 80% level during fill



LP Gas (mostly liquid)
releasing through outage
gauge after fill is complete



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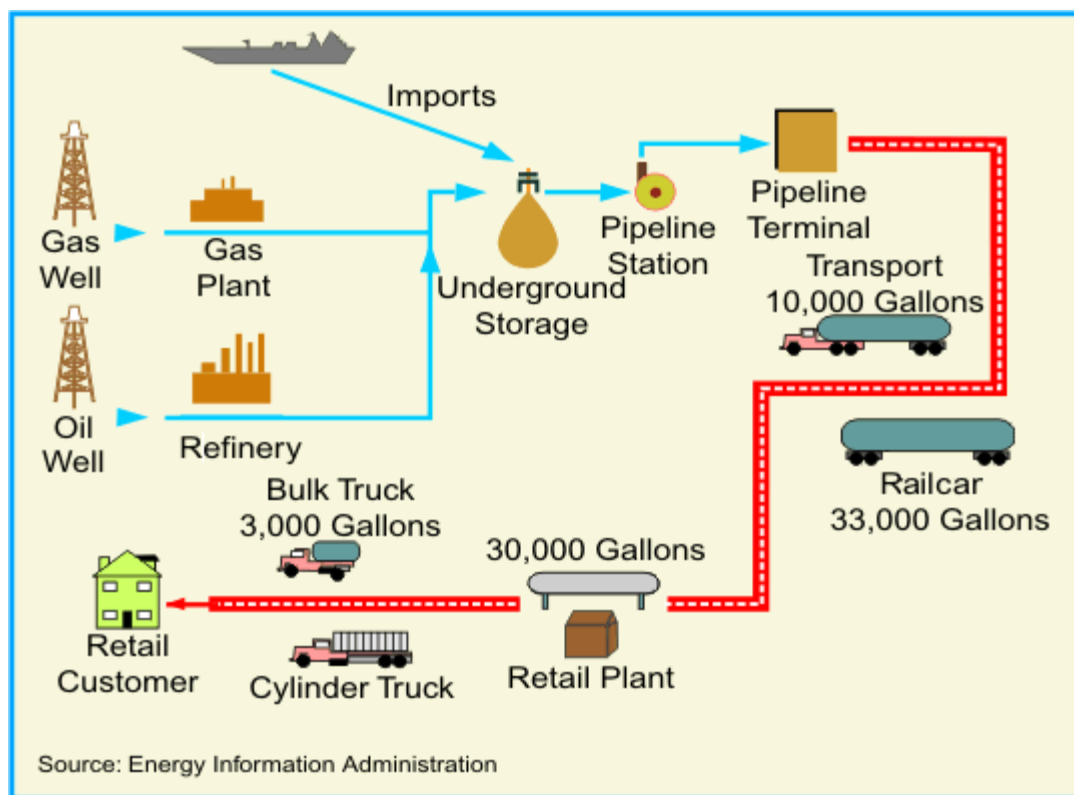
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Range of Typical LP Gas Compositions in CA (est.)

- Ethane: 0.5-3.0%
 - Propane: 80.0-98.0%
 - Propene (propylene): 1.0-20.0%
 - Butanes: 0.5-4.0%
 - Other: <1.0%
-
- ▣ All are **GHG's** (**G**reen **H**ouse **G**ases)
 - ▣ All are **VOC's** (**V**olatile **O**rganic **C**ompounds)
 - ▣ ~10% are **ROG's** (**R**eactive **O**rganic **G**ases)



Typical LP Gas Production & Distribution Paths



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Where do LP Gas Releases Occur Daily? (1)

- Refineries/NGL Plants
- Pipeline Terminals
- Rail Terminals/Railcars
- Port Terminals
- Propellant Plants
- Bulk Storage/ Distribution
- Transport Vessels
 - Bulk Transport
 - Bobtail Transport



Where do LP Gas Releases Occur Daily? (2)

- Refueling:
 - Industrial Sites
 - Commercial Sites
 - Residential Tanks
 - BBQ Tanks (20 #'s):
 - Central Plants,
 - Local Refueling.
 - Automotive Fleets:
 - Buses/shuttles,
 - Forklift Trucks.
 - Other Equipment:
 - Asphalting Machines, Irrigation Pumps, Spray Cans Filling Plants, Bailing Equipment, Lawn Mowers, Telemetry Sites, Railroad Switchers, etc.



Points of Transfer Where LP Gas Outage Gauge Releases Occur

- Refinery or NGL Plant to Rail Car or to Transport
- Rail car to storage tank
- Transport to storage tank
- Storage tank to bobtail
- Bobtail to customer storage tank
- Dispenser to forklift cylinders
- Dispenser to engine fuel cylinders
- Dispenser to BBQ cylinders
- Weight filled BBQ and forklift cylinders

With the exception of the last point, there are significant LP Gas outage gauge releases at each of the above listed points of transfer.



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Part III : The “Outage Gauge”

- Photo of an outage gauge:



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What Is an Outage Gauge? (1)

- The LP Gas releases documented as part of this project are through a device called a “Fixed Maximum Fill Level Gauge” (FMFLG), or a “Fixed Liquid Level Gauge” (FLLG), or an “Outage Gauge”, or a “Spitter Valve”, etc...
- The most common name for this device is “**Outage Gauge**”.



What Is an Outage Gauge? (2)

An outage gauge is a valve with a 0.055" diameter hole (#54 drill size) flow restriction within. This valve is connected to a tube that extends downward into the tank to the ~80% full level (the usual maximum fill level for LP Gas tanks). This tube is typically left fully open during filling, venting gas phase LP Gas until liquid rises to the bottom of the outage gauge tube, at which point liquid LP Gas is observed to escape through an orifice at the top of the outage gauge. The emitted white cloud of mixed liquid and vapor LP Gas signals that the filling must be stopped. The "Outage Gauge" signals when liquid LP Gas has reached the maximum safe fill level.



Quantification of Outage Gauge Releases

- Releases through outage gauges can be:
 - (a) Mostly Gas Phase LP Gas,
 - (b) Mix of Gas and Liquid Phases LP Gas, or
 - (c) Mostly Liquid LP Gas.
- Total releases can be calculated as:

$$\begin{array}{ccccccc} \text{Time} & & \text{Gas Phase} & & \text{Time} & & \text{Liquid Phase} \\ (\text{sec}) & \times & \text{Mass Release} & + & (\text{sec}) & \times & \text{Mass Release} \\ & & \text{Rate (g/sec)} & & & & \text{Rate (g/sec)} \end{array}$$

Note: Field observation indicates that the transition time of mixed gas and liquid phases is negligible.



Part IV : A Minimum First Step: Measuring “K” Factors



ARB, SCAQMD, & ADEPT staff at first outage gauge emissions tests in January 2008



Liquid LP Gas releases through forklift outage gauge



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Mass Release Rate aka “K” Factors (1)

Emissions Mass Release Rate = “K” Factor

“K” Factor values depend on:

- (a) Pressure,
- (b) Temperature, and
- (c) Surface of the outage gauge opening.



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Mass Release Rate, aka “K” Factors (2)

- #54 drill size opening constant across the country for all tanks and cylinders (except for rail cars where it is much larger).
- “K” values measurements were taken with ambient temperatures from 68°F to 72°F.
- “K”s were measured at various pump pressures and without any pump pressure (“Gravity Fills”)



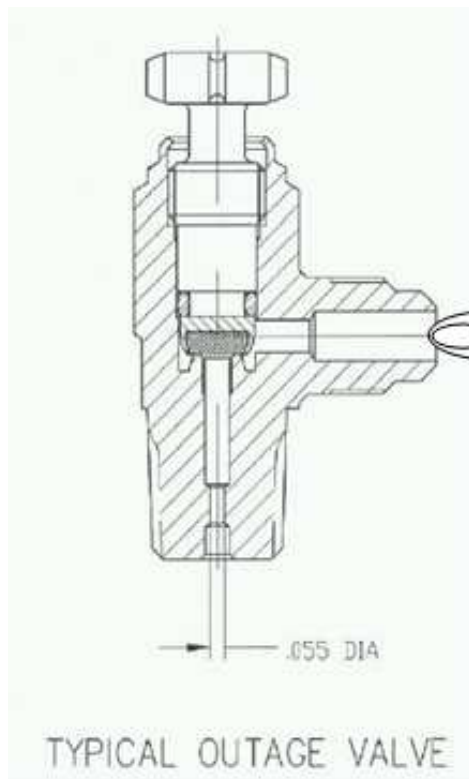
Measured Emission Rates

Type of Re-Fill “K” Factors	with pump assistance	without pump assistance
“K” for Gas Phase	~3g/sec	~2.5g/sec
“K” for Liquid Phase	<i>See below</i>	~10g/sec

- “K” for Liquid Phase with pump assistance was not measured as results exceeded the range of the scale on measuring instrument.
- These “K” values were corroborated by concomitant work conducted by the Source Test Engineering Branch of the Monitoring & Analysis Division of the South Coast Air Quality Management District on November 4, 2008. A Source Test Report was issued by SCAQMD on February 11, 2009.



Outage Gauge Mass Emission Rates



Emissions from a typical outage gauge in California are ~10g/s “liquid” and ~2.5 to ~3 g/s “vapor”



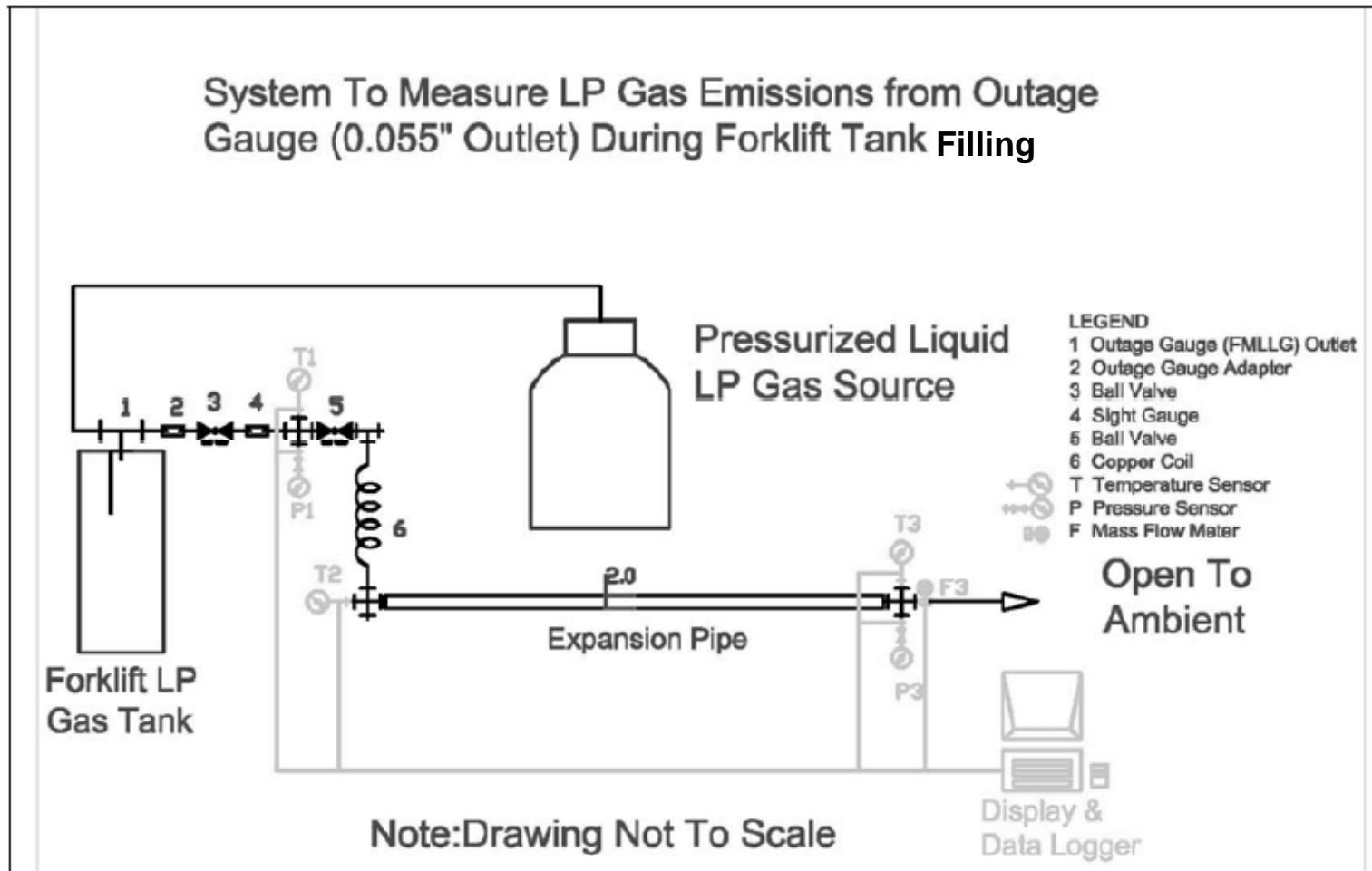
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Instrumentation System Diagram



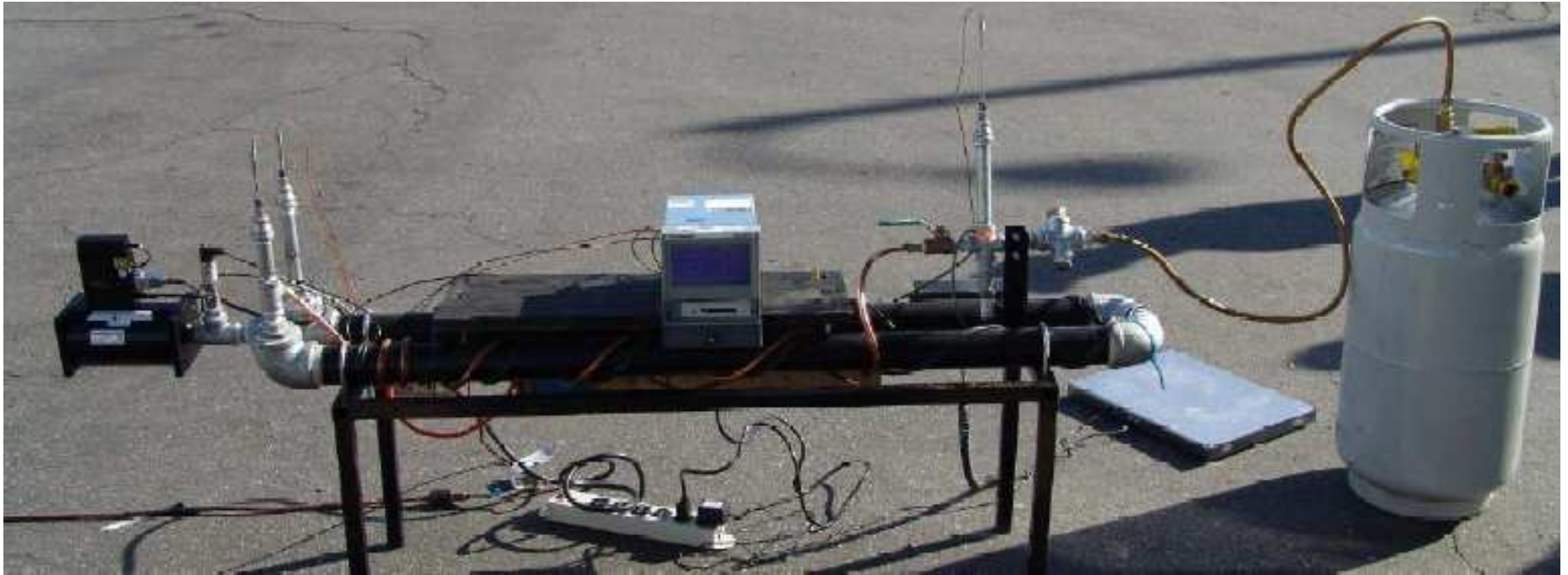
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Instrumentation System used by ADEPT to Measure Outage Gauge Emission Rates



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SCAQMD Test Equipment



Tests conducted in Southern California by ADEPT and SCAQMD engineers on November 4, 2008



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Estimated Cumulative Releases

	California	SCAQMD Only
Forklift Cylinder Refills	~15.6 T/day	~6.2 – ~7.8 T/day
Stationary Tanks Refills	~26.8 T/day	~10.7 T/day
Other*	~110 T/day*	~43 T/day*
TOTAL	~150 T/day*	~60 T/day*

* (Rough Estimate based on a study conducted in 2005
for the LP Gas industry)



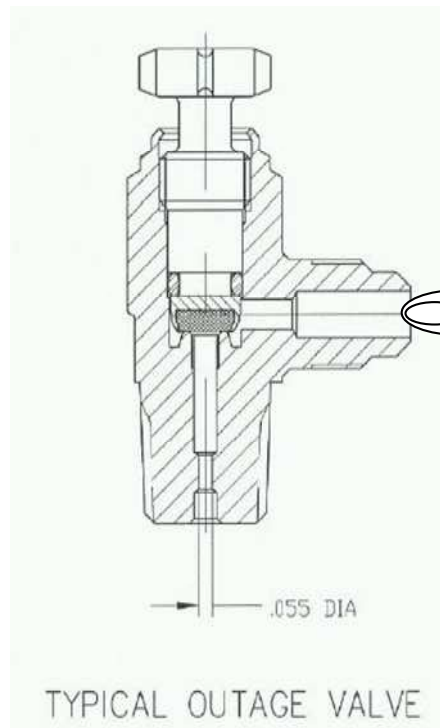
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LP Gas Estimated to be Released Daily in California Through Outage Gauge While Refueling



~ 150 tons/day *

*** Rough Estimate.**



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“OUTRAGE”?

Initial ARB presentation announcement:

We are pleased to announce the next Series topic:

“Maximus TM SFI - Measurement & Reduction of
LP Gas Outrage Gauge Emissions
(Averting Unnecessary Propane Emissions
Into the Atmosphere)“.



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Part V : The Stop Fill Instrument (SFI)



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Q: What is the Stop Fill Instrument (SFI)?

- A non-invasive instrument that can eliminate outage gauge releases while refueling stationary tanks.
- It is hand-held,
- Interactive (easy to use),
- Battery powered,
- Readily attaches to horizontal stationary tanks with magnets, and
- Signals when the liquid level inside the tank rises to the line on which the instrument is positioned (can be used for “partial load” deliveries).



SFI Specifications

Features:

- Accurate.
- Reliable. It uses two redundant liquid level detection processes.
- Opening of outage gauge is **NOT** required.
- No extra LP Gas delivery time is required.

Requires:

- (1) Bubble Level,
- (2) Tank Plate Information:
 - Tank Diameter, and
 - Shell Thickness
- (3) Short Training Period



Part VI : SFI Development Steps

- Lab Bench Tests,
- SFI Initial Field Trials,
- SFI Second Field Trials, and
- SFI Final Field Trials.



Photos of SFI Initial Field Trials (B1)



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Photos of the Second SFI Field Trials (B2)



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Photos of Pre-Manufacturing Prototypes (B3)



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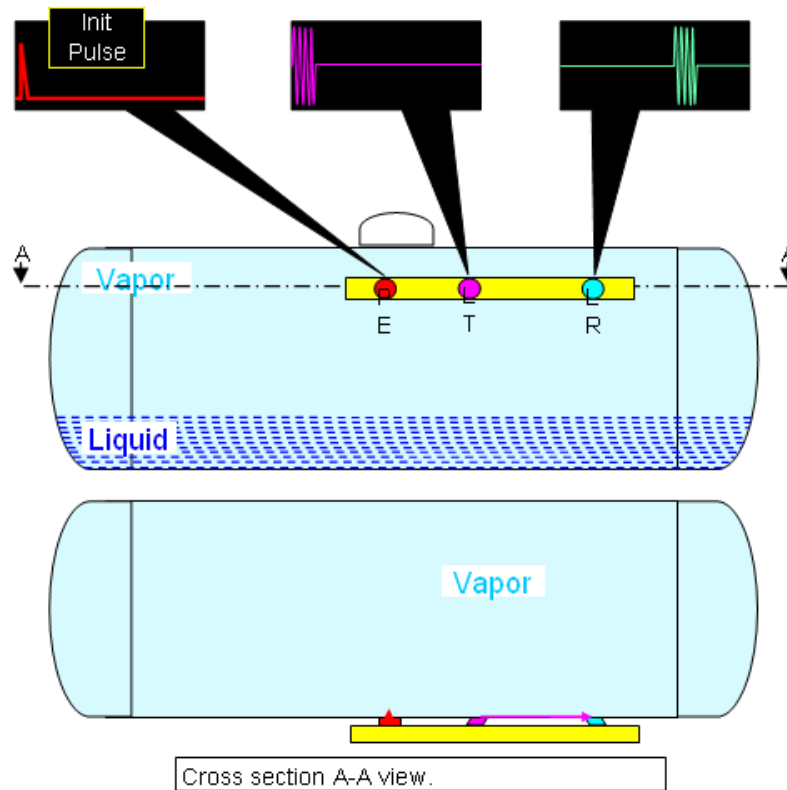
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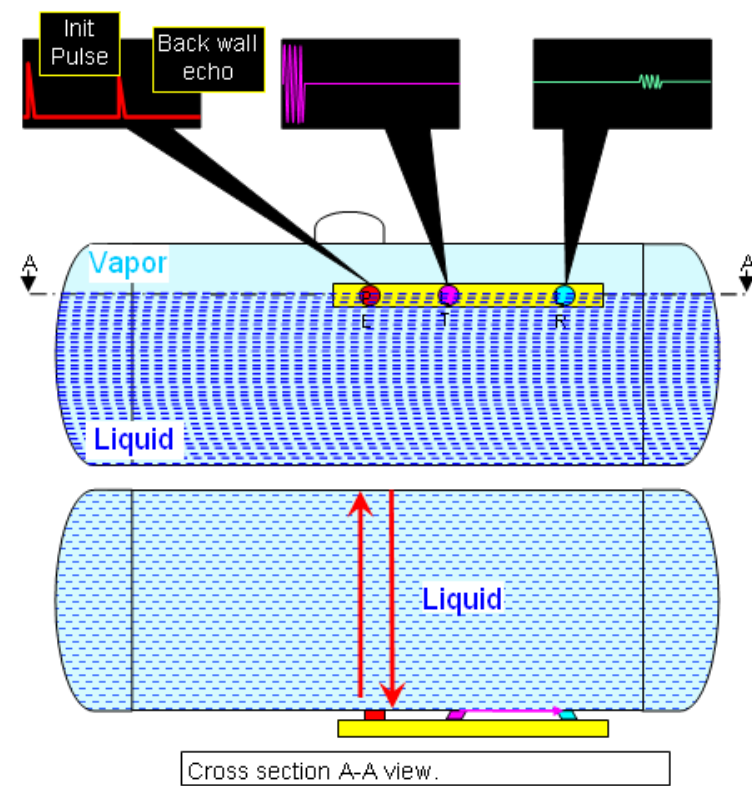
How Does the SFI Works?

The SFI uniquely combines two level detection techniques. This proprietary blending of two level sensing technologies is a world-wide first.

Liquid Level Below SFI Device:



Liquid Level Above SFI Device:



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Maximus™ SFI Potential Benefits

- With current refilling practices the environment is damaged, energy and money are wasted, and unnecessary risks are taken.
- Until now, there were no practical means to avoid outage gauge releases with current LP Gas filling procedures.
- The broad use of the Maximus™ SFI in California will help eliminate ~45 tons/day of VOC's within one (1) year.



Part VII : Conclusions

- LP Gas leaks to the environment every time a tank or a cylinder is refilled.
- Depending on your point of view (or who you work for), such releases range from “significant” to “huge”.
- Appropriate technology is now available to address this problem. With the Maximus™ SFI, the bulk of these outage gauge releases can be eliminated in a cost-effective and timely manner.
- There is a clear urgency to address the above described problem.



Funding Sources

Work presented today was conducted with funding from:

- (1) CARB (under its ICAT program),
- (2) DOE (under its Inventions & Innovations program), and
- (3) SCAQMD (co-funder with CARB).



Thank You

- Thank you for listening to this presentation.
- We also wish to thank CARB, DOE and SCAQMD and all the folks who helped us along the way.



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Q & A



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